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STUDY OF PHASE TRANSITION OF MIXTURE OF SMECTIC AND CHOLESTERIC LIQUID CRYSTAL AND OPTICAL ANISOTROPY WITH TEMPERATURE

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ABSTRACT

The goal of this research is to look at how texture changes as a function of temperature in a mixture of liquid crystalline materials. Also the temperature variations of refractive indices of sample is studied. Theorganic compoundDiethyl4-4lHexaloxy Azoxy Benzoate exhibits Smectic liquid crystalline phase and the compound cholesterylnonanoateis cholesteric liquid crystal. Mixture of 70% Diethyl 4-4lHexaloxy Azoxy Benzoate and 30% of cholesterylnonanoatemolecules exhibits cholesteric, SmA and SmE sequentially when specimen is cooled from its isotropic phase. This is observed at all concentrations of a given combination. The microscopic approach was used to characterise these phases. A Gonio metre spectrometer was used to measure temperature fluctuations in optical anisotropy tests. The temperature changes of liquid crystalline binary mixture refractive indices indicate an almost non linear drop in extraordinary refractive indices with increasing temperature, but a non linear decline and subsequent increase in ordinary refractive indices.

KEYWORDS: Binary Mixture, Phase Transition, Optical Texture & Optical Anisotropy

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I. INTRODUCTION

Many materials that exhibit liquid crystalline behaviour fall into one of two categories: Thermotrophics and Lyotropics. Transition into mesophases obtained by purely thermal process is called “Thermotrophics” where as in which mesophases are obtained by the influence of a solvent on solid is called “Lyotropics”. Thermotropic liquid crystals generally exhibits three types of Phases, namely, Nematic, Cholesteric and Smectic phase. Liquid crystalline materials and their mixture exhibit a multitude of transitions involving new phases. Studies of these phases are of significance in a wide range of scientific fields. Liquid crystalline compounds exhibit optical anisotropy, which has remarkable significance. The temperature dependence of optical anisotropy of liquids crystals is due to the change in their molecular order with temperature. The compound cholesterylnonanoate is a thermotropic liquid crystal exhibits Cholesteric liquid crystalline phase with helical structure. Its molecular formula is $CH_3 (CH_2)_7COOC_{27} H_{45}$ and melting point is 77^0 C to 82^0C. The organic compound Diethyl 4-4lHexaloxy Azoxy Benzoate is a thermotropic liquid crystal exhibits smectic liquid crystalline Phase. Its molecular formula is $C_{18}H_{18}N_2 O_5$and melting point is 122^0C to 123.5^0C .In the present investigation textural changes of mixture of Diethyl 4-4lHexaloxy Azoxy Benzoate and cholesterylnonanoateas a function of temperature is observed and recorded. The present investigation also covered the temperature variations of refractive indices of liquid crystalline binary mixture.

II. MATERIAL AND METHODS

Mixtures of varied quantities of the liquid crystal substance Diethyl 4-4lHexaloxyAzoxyBenzoate and cholesteryl nonanoate were generated in this study. Desiccators were used to keep mixes of varied concentrations of samples for a long time. To achieve homogeneity, the samples went through many cycles of heating, stirring, and centrifuging. With the help of a Gippon-polarising microscope and a hot stage, the optical textures of these mixes at various temperatures are examined and recorded. The materials are sand witched between the slide and cover slip before being firmly sealed for microscopic examination. The reflective indices are measured by the method of minimum deviation using Goniometer spectrometer. The temperature of sample is increased by increasing the voltage across the terminals of spectrometer.

III. OPTICAL TEXTURE STUDIES

The sample's Molecular Orientations of Optical Textures were examined and recorded using a Gippon polarising microscope and a hot stage. The specimen is taken in the shape of a thin film with sand witched between the slide and the covering slip in each case. When cooled from the isotropic phase, a specimen containing 70% Diethyl 4-4lHexaloxy Azoxy Benzoate and 30% cholesterylnonanoate molecules exhibits cholesteric, SmA, and SmEPhases successively. This has been taken down. The genesis of nucleation begins in the form of microscopic bubbles developing radially while the sample is cooled from its isotropic phase, which are characterised as spherulitic textures of the cholesteric phase, as illustrated in figure (a). From 2070C to 1970C, the cholesteric phase ends. As the specimen cools more, the texture gradually changes to a mix of Isogyreslike structure and SmA phase. From 1970C to 1890C, this composition of Isogyres, including structure and SmA phases, is depicted in figure (b). As the specimen cools more, the texture gradually changes to the SmB phase, in which molecules are stacked in layers as seen in figure (c). Between 1890 to 1210 degrees Celsius, the SmB phase exists. As the specimen cools more, the unstable SmB phase transforms into the stable SmE phase, as seen in figure-1 (d).The SmE phase exists from 121^0C to 119^0C. The specimen enters to the crystalline phase on further cooling.

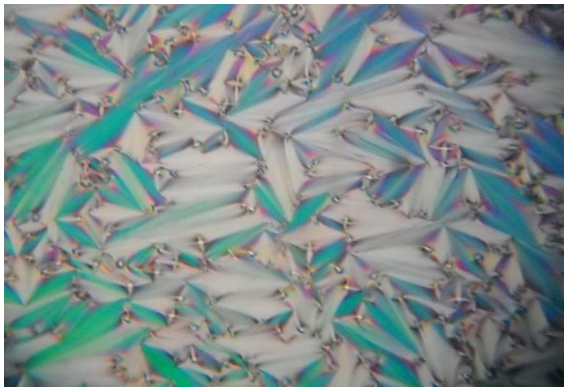

Fig-1(a)

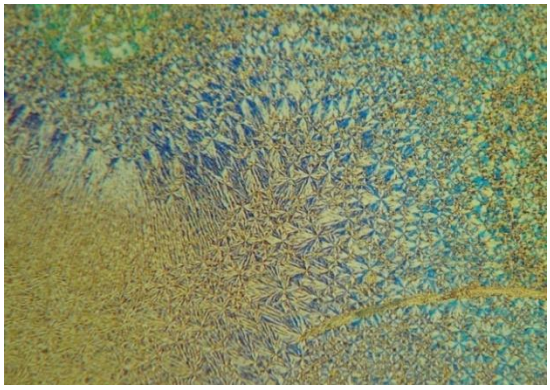

Fig -1(b)

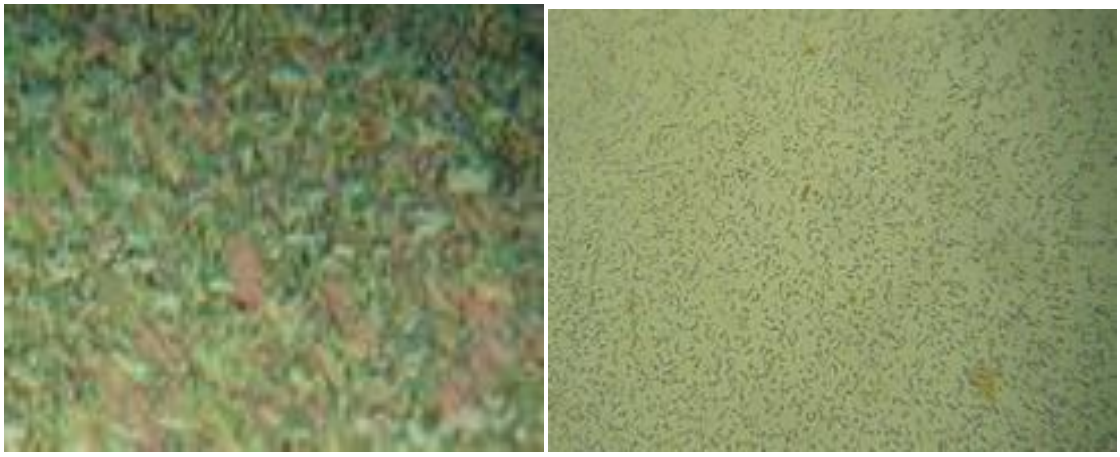

Fig-1(c) *Fig-1(d)*

Figure1: Microphotographs Obtained in between the Crossed Polars 1(a) Spherulitic texture of Cholesteric phase, 1(b)Texture of Composition of Isogyres and SmAphase(250 X), 1(c)Texture of SmB phase(250 X) 1(d)Texture of SmEphase(250 X)

IV. OPTICAL ANISOTROPY

Figure 1 shows the temperature fluctuations of refractive indices for a sample of 70% Diethyl 4-4lHexaloxy Azoxy Benzoate and 30% cholesteryl nonanoate (2). For all temperatures, the value of ordinary refractive index is greater than that of extraordinary refractive index, as shown in the figure. From 1200 C to 1900 C, the value of the exceptional refractive index drops non-linearly before remaining constant from 1900 C to 2000 C. From 1200C to 1700C, the value of the ordinary refractive index falls non-linearly, then climbs non-linearly up to 2000C. Both the ordinary and extraordinary refractive indexes reach the same value at the cholestric-isotropic transition, and both values remain the same from 2000C to 2100C.

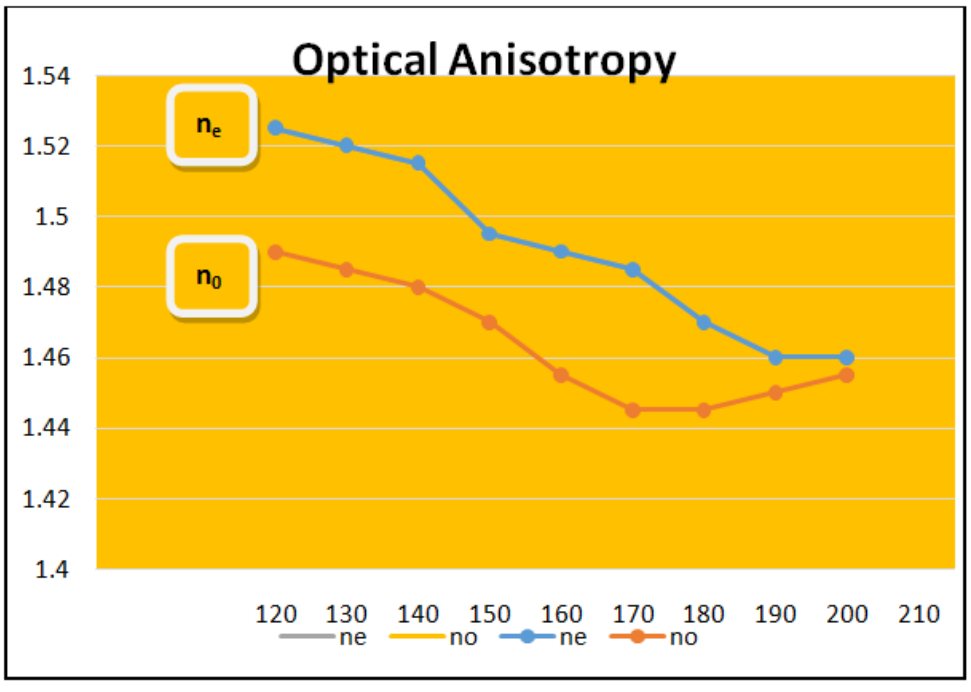

Figure 2

V. CONCLUSIONS

Microscopic analysis of a liquid crystal compound combination when the mixture is cooled from the isotropic phase, 70% of Diethyl 4-4lHexaloxy Azoxy Benzoate and 30% of cholesteryl nonanoate exhibit cholesteric, SmA, and SmE phases successively for all concentrations of the given mixture. The optical texture studies clearly indicates the above sequential phase changes for binary mixture of Diethyl 4-4^{l}Hexaloxy Azoxy Benzoate and cholesterylnonanoate for all concentrations. The temperature variations of refractive indices of liquid crystalline binary mixture shows almost non linear decrease in extraordinary refractive indices with increase in temperature, where as non linear decrease and then increase in ordinary refractive indices with increase in temperature. It is shown that the structural variety of the liquid crystalline state is reflected by their optical anisotropy.

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